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A REVIEW OF THE AIR POLLUTION SITUATION IN THE SALT LAKE VALLEY, UTAH

Donald M. Keagy, et al

Robert A. Taft Sanitary Engineering Center, Cincinnati, Ohio

August 1959

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A REVIEW OF THE AIR POLLUTION SITUATION IN THE SALT LAKE VALLEY, UTAH

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Bureau of State Services
Division of Engineering Services

Robert A. Taft Sanitary Engineering Center
Cincinnati, Ohio

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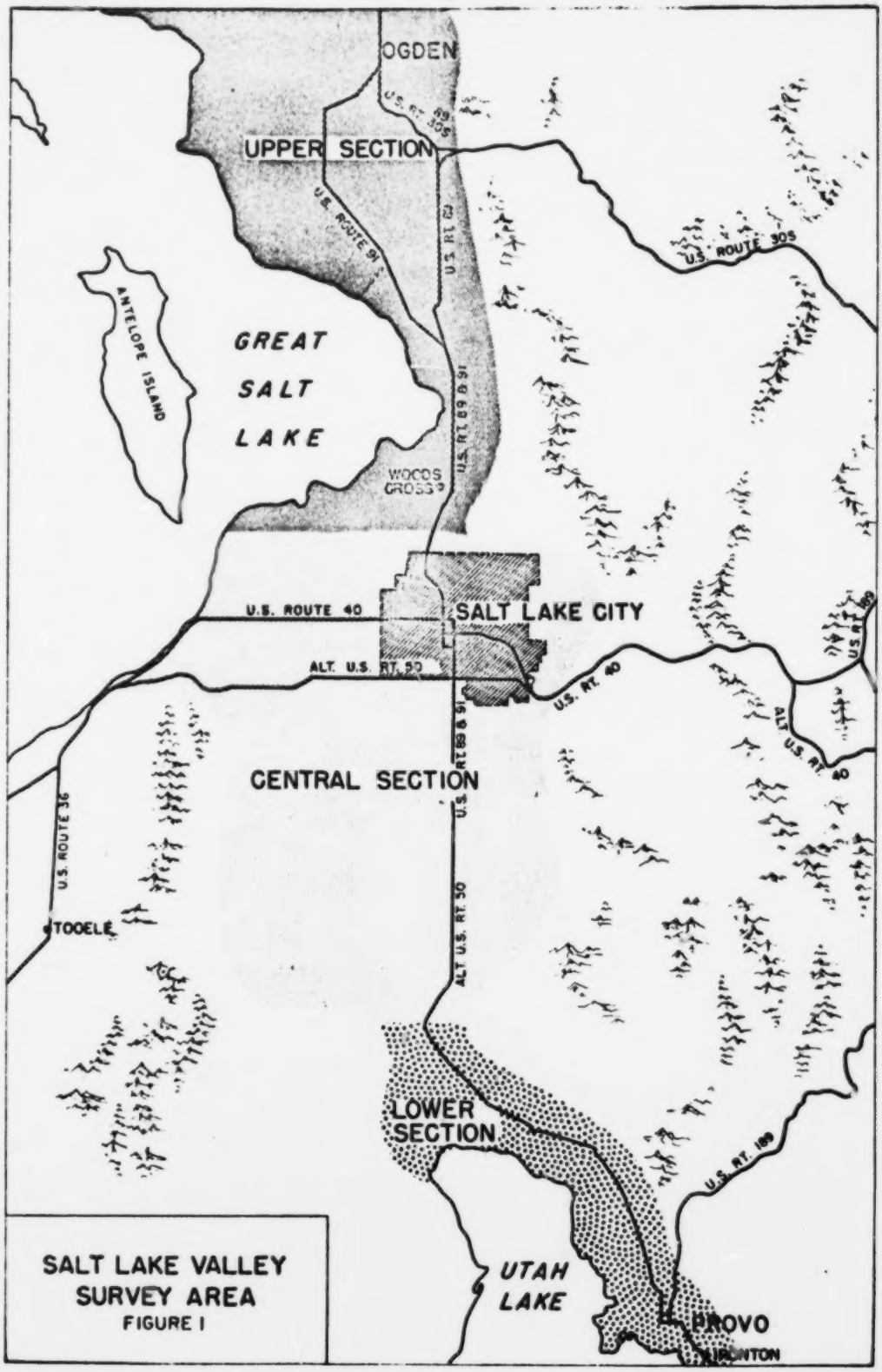
A REVIEW OF THE AIR POLLUTION SITUATION IN THE SALT LAKE VALLEY, UTAH

INTRODUCTION

Between July 1957 and August 1958, much consideration had been given to further studies which might be made of the air pollution situation in the Salt Lake Valley. Several conferences had been held by representatives of the Utah State Department of Health, Salt Lake City Power and Heating Division, the University of Utah, Utah State University, Dugway Proving Ground, the United States Public Health Service, the United States Weather Bureau, industrial establishments in the area, and others. In mid-August 1958, the Public Health Service, the Utah State Board of Health, and the Utah State Department of Health agreed that a one-week review of the air pollution situation in the Salt Lake Valley would be made in October 1958.

The review was conducted by an engineer and a meteorologist from the staff of Air Pollution Engineering Research at the Robert A. Taft Sanitary Engineering Center. Prior to the review, personnel of the Utah State Department of Health, especially Mr. Lynn M. Thatcher and Dr. Grant Winn, assembled reference materials and data, sought cooperation of agencies and individuals, and approached interested parties. The area of concern is depicted in Figure 1. Information was obtained


OGDEN
U.S. RT. 89 & 91
UPPER SECTION
U.S. ROUTE 91
U.S. RT. 89
U.S. RT. 89 & 91
U.S. ROUTE 309
ANTELOPE ISLAND
GREAT SALT LAKE
WOODS CROSS
U.S. ROUTE 40
SALT LAKE CITY
ALT. U.S. RT. 50
U.S. RT. 40
U.S. RT. 189
ALT. U.S. RT. 40
CENTRAL SECTION
U.S. RT. 89 & 91
U.S. ROUTE 36
TOOELE
ALT. U.S. RT. 50
LOWER SECTION
U.S. RT. 189
UTAH LAKE
PROVO
SALT LAKE VALLEY
SURVEY AREA
FIGURE I

during the week of October 20, 1958 through field visits, and interviews, and included material on factors affecting air pollution, previous air pollution studies, sources of pollution, indications of pollution levels, and present control activity.

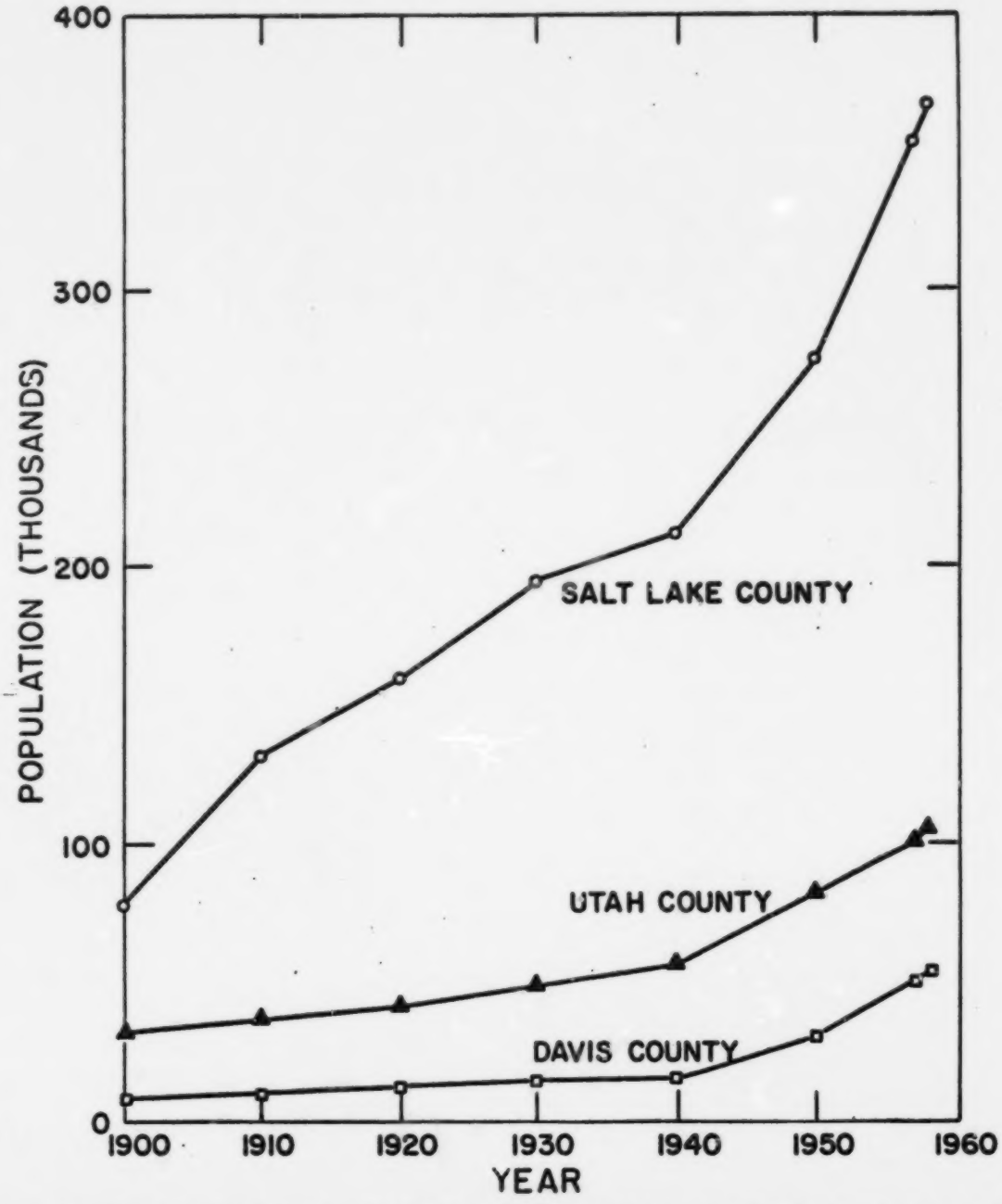
GENERAL FACTORS AFFECTING AIR POLLUTION

POPULATION GROWTH

The population of the Salt Lake Valley has been increasing rapidly (Figure 2). From 1950 to 1958 the increase for the State as a whole was 24 percent. However, 90 percent of this increase was concentrated in the four Wasatch Front Counties (on the western side of the Wasatch Range). Specifically, the increases were as follows:

Salt Lake County	33.8 percent to	368,000 persons
Davis County	76.6 percent to	54,500 persons
Utah County	28.8 percent to	105,000 persons
Weber County	25.4 percent to	104,500 persons

During this same period the rate of increase has been more rapid for Utah than for the United States as a whole, even though nearly half of the State's counties showed a net decrease in population. Utah ranked eighth in the nation in population growth in the period 1950-1957. It is predicted that Utah's population will expand from 833,000 (January 1, 1957) to 1,500,000 by 1975. 1/ The majority of the predicted increase of nearly 700,000 persons is expected to occur in the Salt Lake Valley. This increase in population would result in a significant increase in pollution emissions.



POPULATION GROWTH–SALT LAKE, UTAH, AND DAVIS COUNTIES
1900–1958

FIGURE 2

CHARACTER OF INDUSTRY AND EMPLOYMENT

The manufacturing industries in the Salt Lake Valley are growing rapidly. This is indicated by the 34.5 percent increase in manufacturing employment since 1950 in the Salt Lake County and southern Davis County area and the 30.8 percent increase in Utah County. These increases are comparable to the 33.2 percent increase for the State as a whole.3.4/ The total 1957 labor force for the Salt Lake Valley area (Salt Lake, Utah, and southern Davis Counties) was 182,400. The percentage of workers employed in the agricultural industry has been declining steadily since 1950. 4/ Of the total 1957 labor force, 15.2 percent were employed in manufacturing industries and 5.5 percent were working in agriculture.

In 1957 there were 1116 manufacturing establishments in Utah of which 662, or 57 percent, were located in the Salt Lake Valley. Of those in the Valley in March 1958, 184 employed 20 persons or more and were distributed by type as follows:3.5/

Food and Kindred Products	59
Fabricated Metal Products	21
Printing, Publishing & Allied Industries	16
Stone, Clay & Glass Products	15
Chemicals & Allied Products	11
Apparel and Other Finished Products	10
Machinery except Electrical	9
Primary Metals Industries	8
Furniture & Fixtures	7
Electrical Machinery, Equipment & Supplies	6
Products of Petroleum and Coal	5
Lumber and Wood Products	5
Paper & Allied Products	3
All Others	9
	184

Of these 184 establishments, 161 are in Salt Lake County, 16 are in Utah County, and 7 are in southern Davis County. 5/ Over one-third of the persons employed in these 184 industries in 1957 worked in the primary metals industries. This is 5.3 percent of the total labor force. 6/ In Utah County the predominant manufacturing industry by far, from the standpoint of employment, is primary metals. Seventy-two percent of the manufacturing employees work in the six foundry and steel plants located in this county. 3,6/ The predominant industry in southern Davis County is petroleum. Over half of the manufacturing employees are engaged at four refineries and one asphalt plant. 3,6/ The manufacturing employment in Salt Lake County is fairly well distributed but more persons are employed in the primary metals industry than any other. Other industries in order of numbers employed are: food; products of petroleum, coal, and chemicals; fabricated metals; machinery; printing and publishing; and stone, clay, and glass. 6/

Utah, and particularly the Salt Lake Valley, is located at the heart of a great and growing far western market. Four railroads provide direct rail connections to the major cities, and the airlines and highways radiate in seven directions from Salt Lake City. This central position provides an advantageous location for assembling raw materials and for distributing finished products. Within this greater market there is another highly developed trade area, of which Utah is again the center. This is known as the Intermountain Empire - - a rapidly growing market of two million consumers. 3/ The Bureau of Economic

Research, University of Utah, reports that Utah and its immediate surroundings have greater quantities of more types of industrial raw materials than any other comparable area known. Utah has become a source of many semi-finished or finished production materials such as pig iron, steel, refined copper, cobalt, products of petroleum and coal, cement, and various chemicals. 3/ Salt Lake County and neighboring Tooele County constitute the world's largest non-ferrous smelting center. The West's largest and the Nation's most modern steel plant is in Utah County. The West's first large copper refinery is at Garfield. The greatest known deposit of coal, both bituminous and coking, is in fields located largely in Utah. It is the westernmost deposit of significant quantities of coal in the United States and provides the West Coast states with most of their coal supply. Oil production and refining is a major Utah industry. Electrical generating capacity is currently undergoing a great expansion which assures an abundance of power for industrial expansion. 3/ The foregoing indicates that the trend is toward rapid development and expansion of industry in the Salt Lake Valley and that the potential for continued growth is great. Pollution emissions associated with certain industries would be expected to increase concurrently, unless control measures are applied.

LAND USE

From information on a limited number of land use maps and personal observations of the investigators, land use may

be generally described as consisting of three parallel belts. Newer residential areas lie at the base and in the foothills of the western side of the Wasatch Range; commercial and older residential areas are to the west of the newer residential sections; and a broad industrial area lies in the central flat lands of the Salt Lake and Utah Valleys. Except for the industrial development in the Garfield vicinity (west of Salt Lake City) there is considerable undeveloped or agricultural land west of these three belts. With this pattern of land use, pollution emissions from home heating plants and other domestic and commercial sources is mixed with industrial emissions within the broad valley area paralleling the Wasatch Range.

TOPOGRAPHY

The region of interest in this survey (Figure 1) possesses many features of an inter-mountain valley. It extends north and south about 80 miles, (Ogden to Ironton) and averages about 15 miles east and west. Salt Lake City is located a little north and east of the center of the valley. The valley, with an average elevation of 4200 to 4500 feet above sea level, is bounded on the east by the north-south Wasatch Range which rises to an average height of 6000 feet above the main valley floor. On the west, across the central and southern portions of the valley, are the north-south Oquirrh Mountains which have an effective ridge height of about 3500 feet. To the northwest and southwest, the valley merges into the waters of the Great

Salt Lake and the Utah Lake respectively.

The extended valley can be divided into three topographic sections: lower section, the Utah Valley; central section, the Salt Lake Valley; and upper section, the valley north from Salt Lake City to Ogden. The Salt Lake Valley is the area of prime interest, for within this section are about 450 square miles - about one-half of the total survey area, and about three-fourths of the population in the survey area.

The southern portion of the Salt Lake Valley narrows and steepens and is separated from the Utah Valley by the east-west Traverse Range. The central plain of the Salt Lake Valley slopes downward from about 4500 feet at the Traverse Range to about 4200 feet at the Great Salt Lake. The north-flowing Jordan River bisects the Salt Lake Valley Plain and drains Utah Lake (4500 feet) in Utah Valley, through the Traverse Range and into Great Salt Lake, (4200 feet).

The valley floor of the three sections consists of two parts; the broad flat central plain and the narrow sloping terrace that connects the valley plain with the bordering mountains. These mountains, particularly the Wasatch Range, are cut in many places with deep canyons which adds to the heterogeneous configurations of the mountain slopes. The Great Salt Lake and the fresh water Utah Lake flank the upper and lower sections respectively, on the west. In general, the topography of the region may be considered unfavorable to the rapid disperaion of pollutants emitted to the atmosphere, es-

pecially during adverse meteorological conditions.

CLIMATOLOGY

Regional

The Salt Lake region has a semi-arid continental climate 7/ with cold, dry winters and hot, dry summers. In late spring and summer (April through August) the region is dominated by warm, dry, relatively stable westerly winds of the Pacific High or by hot, dry, less stable southerly winds of the Thermal Low to the southwest. During spring and summer the climate is generally favorable for dispersing pollutants. With long days, daytime heating reaches a maximum and thermal instability tends to keep the lower layers of air stirred and the area adequately ventilated. With short nights, nighttime stability is at a minimum and shallow nocturnal inversions usually dissipate shortly after sunrise. Extreme daily temperature ranges during this period favor the development of diurnal winds and the frequent occurrence of afternoon thundershowers, both of which play important roles in the more rapid transport and dispersion of pollutants.

In fall and winter (September through March) the region is sometimes dominated by easterly moving maritime air from the Pacific High. The air is relatively dry and stable as a result of the dynamic process of subsidence, associated with high pressure systems, and additional orographic "drying out" as air moves down over the Sierra-Cascade Mountains. In winter

the region is often influenced by dry, cold, stable air from the Great Plains which spills over the Rocky Mountains and fills the Great Basin. Such occurrences are generally associated with some of the more pronounced air pollution accumulations in the Salt Lake Valley region. 8/ The winter period is also marked with variable weather resulting from the invasion of migratory pressure systems with their periodic frontal passages and changes in air masses. Several times per winter, following passages of active cold fronts, cold, dry, stable air may move into the Great Basin and stagnate for several days - sometimes several weeks - and severe pollution accumulations may occur. 8/

Local

Because of the mountain-valley features of the area, local climatology plays an important role in air pollution considerations.

Wind - Winds are generally diurnal in nature and, are influenced by the mountain-valley topography. At Salt Lake City, over a long time period (1918-1940), winds were found to be predominantly northwest by day and southwest by night. The double mode of directions may vary somewhat in localized areas depending upon alignment of the valley and proximity to the mountain canyons. Mean annual velocity of daytime winds (1500 MST) is about 9 mph and nighttime winds (0300 MST) about 7 mph. Summer season winds of 8 mph are consistently greater

than winter season winds of 6 mph. The duration of valley winds according to Salt Lake Airport Weather Bureau data for 1943, varies slightly between summer and winter. The average duration of night down-valley winds is about 15 hours (2100 to 1200 MST on the following day) and of day up-valley winds about 9 hours. The influence of the diurnal winds of the Salt Lake Valley does not extend above about 9800 feet (MSL) or 5600 feet above surface. This finding is based on pilot balloon observations made during 1930-1942 at 0300 and 1500 MST. It was also found that the direction of the 0400 MST down-valley wind moves clockwise about 15 degrees per 1000 feet to southwesterly at 5100 feet above the surface, and conversely the 1600 MST northwesterly up-valley wind moves counter-clockwise about 15 degrees per 1000 feet to southwesterly at the same 5100 foot level. Winter diurnal winds are in the mean about half the depth of the summer winds. This phenomenon is due to higher average gradient wind velocities in winter (January - 19 mph) as contrasted to the average gradient wind velocity in summer (August - 11 mph).

The foregoing discussion provides background information for estimating the probable depth and horizontal extent of valley air movement. From a study by Hawkes 9/ in September 1943, it was estimated that the air in the vicinity of Salt Lake City during the month was mostly confined to an area bounded by North Logan to the north and Ironton (3 miles south of Provo) to the south. Calculation of this transitory

wind movement is based on duration of valley winds and average wind velocities. No wind trajectory analysis, however, was found to substantiate this hypothesis. It has been noted that in fall and winter, light valley winds often confined the major portion of visible Salt Lake City "smoke pall" to an area extending about 15 miles north and 15 miles south of Salt Lake City.

Stagnation Periods - Stagnation periods, as discussed here, exist when an area of relatively high atmospheric pressure (anticyclones) dominates a region for several days or weeks with very slight movement of the system. No statistical information was found on the frequency of stagnation periods over the Salt Lake area. However, this plateau region of the United States is a favored place for winter anticyclones and periods of persistent anticyclonic stagnation may be expected from a few to perhaps 10 to 20 times each winter season. 8/ Any one occurrence may persist from two or three days to two or three weeks. During these periods marked accumulations of pollution in the Salt Lake Valley are likely. 11/

Stability (Inversions) - Dickson 12/ gives a good account of local low-level inversions in the Salt Lake Valley. His study extended over a ten-month period from August 1[illegible] to May 1957. From 548 inversion cases based on upper air data from the Salt Lake Airport Weather Bureau Station, taken at 0230, 0830, 1430, and 2030 MST, he found that thirty-seven percent of all inversions had a magnitude of 5 degrees or more.

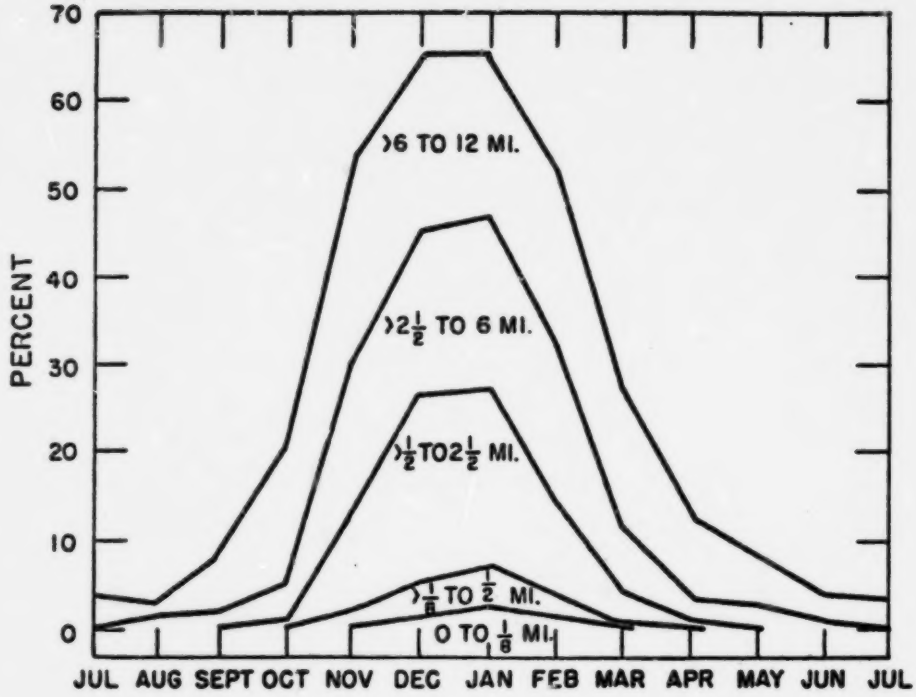
The average and also most frequent value was 3 degrees (All temperatures being reported in degrees Fahrenheit). He also found the average depth of inversion to be 770 feet. The maximum depth occurred during December (1346 feet), and minimum depth occurred during March (521 feet). The most frequent surface wind direction during inversions was southeast. At an elevation of 7000 feet (MSL) the most frequent direction was southwest and at 10,000 feet (MSL), southwest. It is significant from an air pollution potential standpoint that during the ten-month period, inversions existed in 548 of about 1200 observations, or almost 50 percent. The study shows that fall and winter are the two seasons when air pollution would most likely become severe.

Visibility - Based on data collected prior to 1941, Salt Lake City Municipal Airport had the highest percentage of low visibilities (1½ - 2 miles) during the winter season, (Dec - Jan - Feb) of all weather stations west of Omaha.13/ These restricted visibilities were due, in the large majority of cases, to the presence of air pollution (smoke). Prior to 1941, most furnaces for heating purposes were coal-fired. Since then there has been a steady transition toward the use of gas instead of coal with a resulting probability that there has been a reduction in the emission of smoke. Nevertheless, these data are of value for showing the relatively high levels of pollution in the area during certain periods, as compared

to other western cities, and for observing seasonal variation in visibility (Figure 3).

Visibility conditions in the salt Lake Valley have been summarized as follows:11/ (1) visibility is markedly seasonal; (2) a fundamental requirement for low visibilities is a weak circulation, predominantly southerly, in the lower 2000 feet; (3) under conditions of light circulation in low levels there is, particularly with the common winter high pressure system, a decided diurnal regime in visibility due mostly to local drainage winds, with a lowering of visibility at about 2100 MST and remaining fairly constant during the night. A sharp lowering occurs about 0800 MST, followed by slight improvement from about 1000 MST till noon when the shift to counter-drainage wind is followed by further improvement in visibility during the afternoon; (4) under typical winter anticyclonic conditions there is an "aging" effect or a gradual lowering of visibility through the first few days and then finally leveling off to more or less constant values.

Fog - The occurrence of fog is generally limited to the period from November through February and varies widely from year to year. Based on a study 11/ of 26 years of Salt Lake City Weather Bureau data it was found that fog may accompany about ten valley inversions yearly. Maximum intensity will usually occur in mid-winter during stagnating anticyclonic conditions when the lower air layers are cooled below their dew point. Such fogs may persist for several



DISTRIBUTION OF VISIBILITIES BASED ON ALL THE HOURLY OBSERVATIONS FROM FEBRUARY 1, 1930 THROUGH DECEMBER 31, 1938. SALT LAKE CITY AIRPORT

FIGURE 3

days, sometimes weeks, if solar heating is too weak to dissipate it. Sometimes fog occurs after passage of active cold fronts followed by well developed high pressure systems which move into the area behind the fronts and stagnate for many days or weeks. Some of the most severe air pollution episodes in the Salt Lake Valley area are likely to occur during such periods, particularly in the presence of persistent fog.

Precipitation - Rainfall is generally light during summer and early fall and reaches a maximum in spring. Summer precipitation is usually associated with thundershower activity. Most winter precipitation is in the form of snow and sleet. Precipitation "washout" of pollutants therefore would generally be associated with frontal and/or thundershower activity and would be of "short duration".

Degree Days - A tabulation 7/ of occurrence of degree days provides a rough index for determining seasonal distribution of pollution added to the atmosphere from home and industrial space heating sources:

January	1194	May	253	September	88
February	885	June	81	October	381
March	741	July	0	November	771
April	453	August	0	December	1039

The highest occurrence of degree days falls within the period from September through March, the same general period when climatological conditions are generally most favorable for local pollution accumulations.

Land-Lake Breezes - Little information was found relating to land and lake breezes in the vicinity of the Great Salt Lake. No known studies have been made on the subject. 8/ From limited data Hawkes found evidence of a weak lake breeze around 0830 MST near the shore of the Great Salt Lake, just north of the Oquirrh Mountains. 9/ However, there was no evidence of the counterpart of this wind in an evening land breeze. Hawkes states that undoubtedly land-lake breezes do occur; however, they are extremely weak and probably have little influence on local wind patterns.

PREVIOUS STUDIES

A large amount of climatological and meteorological data have been collected in the Salt Lake region. In addition to regularly operated weather facilities, there have been many special meteorological and climatological investigations conducted by the U. S. Weather Bureau, Hill Air Force Base Weather Detachment, the University of Utah Meteorology Department, Salt Lake City Power and Heating Division, and several industrial and private agencies, including American Smelting and Refining Company and U. S. Steel, Columbia-Geneva Division.

In April, 1958, Lloyd B. Lyon prepared a report concerning various aspects of the air pollution situation in the Salt Lake Valley, 14/ in which he listed and reviewed previous studies. The following material is largely abstracted from

his report.

A joint survey was conducted by the U. S. Bureau of Mines, Salt Lake City, and the University of Utah. Work was started in 1919 and a report (among others) was published in 1926.15/ The report describes the methods advocated by the Bureau of Mines for smoke abatement. Data collected included Ringelmann Chart readings, sulfur dioxide concentrations, and dustfall measurements. The solids concentration in the air reached 2500 micrograms per cubic meter during the heating season in the business district. Total sootfall was reported to average 250 tons per square mile per annum during the heating season, forty percent of which was combustible matter. Sulfur dioxide values averaged 0.15 ppm (parts per million) during December and January. Smoke concentration and sootfall were reported to be as high as that in cities consuming 5 to 10 times as much coal.

During the twenties and the early thirties, the U. S. Bureau of Mines conducted extensive research on low temperature carbonization and gasification of Utah coals as a means of providing a smokeless fuel for use in abating the smoke problem. (Lyon 14/ gives a list of publications resulting from this work.)

In 1937 the State of Utah appropriated $25,000 to the Utah Conservation and Research Foundation for the purpose of studying various means of processing Utah coals for production of smokeless fuels and other products. A report10/ was submitted to the state in 1939 which further stimulated interest in the application of low temperature carbonization of coal as a means of providing a fuel to further smoke abatement.

During the period 1940-'48, the State of Utah financed the operations of a private organization in the development and installation of a plant to produce a smokeless fuel from Utah coals. The method used was named the "Coal-Logs Process". (No further information on what resulted from this project is given by Lyon.)

The Salt Lake City Power and Heating Division has made dustfall measurements since 1942. The city's records state that dustfall has decreased from 81.4 tons per square mile per month in 1942 to 21.9 in 1957. The data are averages of measurements made at 62 stations. The percent of organic matter in this dustfall decreased about 90 percent during this time.

In 1949 the U. S. Public Health Service, in conjunction with the Utah State Department of Health, inaugurated a program to study air pollution, principally the aspect of fallout from Atomic Energy Commission tests at Yucca Flats, Nevada.

Since 1919, some industries especially American Smelting and Refining have operated field air pollution sampling stations and made studies of effluents from their establishments and their effect upon agriculture. Geneva Steel has made extensive studies relative to the fluorine problem. There is said to be millions of dollars worth of data in various company files.

In addition to studies mentioned in Lyon's report, other work has been done. The Industrial Hygiene Field Station of the United States Public Health Service and the Division of Occupational Health of the Utah Department of Public Health, in cooperation with the Power and Heating Division of Salt Lake City, conducted a limited study of air pollution during February and March, 1951. 16/ Air samples were taken during a six-week period at 9th South Street and Second West Street. Measurements were made of total particulate loadings of the atmosphere, sulfur dioxide concentrations, and meteorological parameters. The highest particulate loading for any one hour, as determined from electrostatic precipitator samples, was 814 micrograms per cubic meter as compared to the earlier cited value of 2500 in 1919-1926. There were many values over 300 micrograms per cubic meter in February 1951. When computed according to hour of the day, the average concentration was highest at 8:00 a.m., being 271 micrograms per cubic meter. Reflectance readings were made on hi-volume air filters which confirmed the results of the precipitator

samples, indicating that the heaviest pollution occurred at 8:00 a.m. Comparing these data with the meteorological data, it was shown that pollution conditions were closely related to atmospheric stability conditions. The benzene-soluble content of a composite of particulate matter collected during the study was determined to be 20.9 percent. A spectrographic analysis (of the same composite sample) was used to measure the concentration of 19 elements. The most abundant were found to be calcium aluminum, iron, and lead.

Studies of fluorides in the atmosphere and their effects on plants and animals have been conducted at the Utah Agricultural Experiment Station of Utah State University at Logan, Utah for a number of years. Many publications have been prepared relative to the work.17,18,19,20,21,22/ It is noted that none of these publications include data on atmospheric concentrations of fluorides.

SOURCES OF POLLUTION

FUEL USE

The 1954 United States Census of Manufacturers presents data which show that the value of fuels and electric energy used annually by Utah manufacturing industries has doubled since 1947. In the same seven-year period, the amount of coal used decreased by 20 percent; the use of coke remained about the same; fuel oil consumption increased 320 percent to nearly one million barrels; gas consumption increased 37 percent

to nearly 93 billion cubic feet; and electric energy use increased 130 percent to 840 million kilowatt hours.

The type of fuel used for home heating has reportedly followed a trend away from soft coal to gas, but the present ratio of use of the two fuels was not available.

Motor vehicle fuel consumption is probably consistent with that in other areas. The total gasoline consumption in 1957 for the entire State was 278 million gallons. Using population distribution as an index, approximately 75 percent of this fuel was consumed in the Salt Lake Valley area.

Two 300,000 kilowatt power plants are located in Salt Lake County: the Utah Power and Light plant west of downtown Salt Lake City and the Kennecott Copper plant near Garfield.

The principal exhaust emissions from the burning of coal include particulate matter, sulfur dioxide, acids, and organics. From the combustion of natural gas the principal emissions are nitrogen oxides, organics, and acids. Hydrocarbons and oxides of nitrogen constitute the greatest weight of emissions of pollutants from automobile exhausts.23/

It was reported that the Salt Lake City Heating and Power Division has extensive data on fuel use in the area. Not having been made available, that information has not been used in the preparation of this report.

INDUSTRIAL ACTIVITIES

The primary metals industry undoubtedly is the major source of industrial pollution. In the Utah Valley there is

a large steel mill, two small blast furnaces and a coking plant at Geneva, and some foundries near Provo. In Salt Lake County there are five gray iron foundries, two brass foundries, one steel foundry, one lead smelter, two copper smelters, and one other non-ferrous smelter. Over the years there have been 27 smelters in the area, but at the present time there is none operating in the immediate vicinity of Salt Lake City. The nearest are the two large ones near Garfield. Other industries which constitute major sources of pollution include five oil refineries, two cement plants, two rock wool insulation plants, brick plants, a large sulfuric acid plant, and salt plants.

REFUSE DISPOSAL

Nearly all domestic garbage and rubbish produced in the Salt Lake Valley is disposed of at open dumps in the Salt Lake Valley. There have been seven of these dumps in Davis County and six in Salt Lake County. Detailed data for Utah County were not made available but it is understood that the open dump is the predominant method of disposal. In Davis County, efforts are being directed toward eliminating open dumps and replacing them with sanitary landfills. Effective January 1, 1959, communities in the northern half of the county, except Syracuse, were to abandon three open dumps they were using and operate a landfill. Syracuse plans to continue use of its dump. In the southern half of the county,

one dump (Farmington) has been abandoned, and efforts are being directed toward establishment of a sanitary landfill to serve the area and thus eliminate the other two dumps. Salt Lake City disposes of all of its refuse at a dump eight miles west of the center of the city. The remainder of the communities in Salt Lake County utilize five open dumps distributed over the western half of the county. No detailed information was obtained regarding commercial and industrial refuse disposal practices.

INDICATIONS OF POLLUTION LEVELS

No routine air sampling activities are being conducted in the area of study by local governmental agencies except for the activities of the Salt Lake City Heating and Power Division, and data from the latter were not made available to the investigators. Several of the larger private industries have been conducting air sampling and other air pollution studies for a number of years, partly as a result of law suits against the companies for damages alleged to be caused by the industries. It was indicated that there are extensive data concerning air quality in industry files.

The only available current data on pollution levels are those of the U. S. Public Health Service National Air Sampling Network, which provides analyses of suspended particulate matter collected by high volume air samplers. During the period 1953-1957 the particulate matter concen-

tration for the Salt Lake City station averaged 176 micrograms per cubic meter, ranging from 54 to 1070. The average for all cities in the network for the same period was 163 micrograms per cubic meter. During 1957 and '58 the average at the Salt Lake City station was 115 with a range of 44 to 267 micrograms per cubic meter. The average for all cities in the network for the same period was 131.

A collection of newspaper accounts and photographs regarding air pollution has been made by the State Department of Health.24/ Among items collected during the period 1949-1957 are reports of health effects (nausea and nose and throat irritation), materials damage (pitting of windshields of autos), agricultural damage (sulfur dioxide damage to leaves, fluoride damage to cattle, reduction in bee populations, and effects of contaminated forages on horses), greatly reduced visibility, excessive dustfall and odors.

During the one-week survey, the investigators observed the odor of sulfur dioxide in the Garfield area, and odors of oil refineries in the North Salt Lake and Woods Cross area. A pollution pall over Salt Lake City and plumes from a cement plant, the smelters at Garfield and Tooele, and refuse dumps were observed.

A recent newspaper account (November 11, 1958) notes that "a 'sea of smog' settled over the area about two years ago and lasted for about 10 days. However, through the

efforts of city and county officials and the cooperation of industry, no prolonged, serious problems have existed."

PRESENT CONTROL ACTIVITY

There is no State law pertaining specifically to the study and control of air pollution. Salt Lake City is the only municipality in the State having an air pollution control ordinance. It was passed May 14, 1941. Title 31 of the City Code 25/ provides for establishment of the Salt Lake City Power and Heating Division and a subdivision thereof designated as the Air Pollution Control Division, both of which are under the general direction of a Chief Engineer. Chapter 11 of Title 31 of the City Code is the Air Pollution Control Division Code. It permits the appointment of a seven member advisory committee, and a board of appeals. It requires that permits be obtained for construction, reconstruction, repair, or use of combustion equipment and requires the use of mechanical firing equipment or smokeless fuel. It limits the use of steam locomotives and declares the emission of dense smoke (Ringelmann No. 2 or greater density) to be a nuisance. Emissions of pollutants which cause injury, detriment, or nuisance are prohibited. The code provides for the right of entry by inspectors, the keeping of certain records, and the imposition of penalties.

Several persons stated that emission of particulate matter within the Salt Lake City limits has been reduced sub-

stantially as a result of the ordinance and enforcement activities. It was also stated that natural gas was brought to the area after passage of the ordinance, and the subsequent conversion of combustion equipment from coal to gas-firing was responsible for much of the reduction in particulate pollution emissions.

In addition to conducting sampling activities and extensive research activities, several of the larger industries have expended considerable effort and funds toward reduction of pollution emissions. An outstanding example is the seven-year, nine-million dollar effort by the Columbia-Geneva Division of U. S. Steel (Provo, Utah) which resulted in the removal of about 96 percent of the fluorine and fluorides in the effluent from the sintering plant and the open hearth department. The one-million cubic feet per minute capacity of the precipitation system made it the world's largest.24/ Another example is the twelve-million dollar expenditure by American Smelting and Refining Company in 1949-1950 for a new sulfuric acid plant to control sulfur dioxide gases at Magna.24/ Kennecott Copper Corporation has conducted considerable research on the odor problem connected with their Garfield refinery. This was followed by the installation of two scrubbers in 1954 and additional equipment in 1955. One of the most recent control efforts concerns the Portland Cement plant located within the Salt Lake City limits. Company ap-

proval was given for an expansion program which would double the plant capacity and provide equipment to eliminate smoke and dust annoyance, according to the president of the company.24/

SUMMARY

Air pollution in the Salt Lake Valley area has long been recognized as a problem by public and private organizations and by many individuals. Air pollution has been responsible for complaints of offensive odors, irritation of nose and throat, reduced visibility, annoyance due to dustfall, and damage and soiling of materials. Law suits proclaiming damage to livestock and crops due to air pollution have resulted in extensive expenditures of private funds and effort for research and control.

After a series of communications and meetings, the Utah State Board of Health requested the Public Health Service to conduct a survey of the air pollution situation in the area. The survey was made during the week of October 26 by an engineer and a meteorologist of the staff of Air Pollution Engineering Research of the Public Health Service with the assistance of staff members of the Utah State Department of Health.

Major air pollution sources in the area include burning of fuels for heat and power, motor vehicle operation, refuse disposal practices, and processing activities

of various industries, such as primary metals, stone and clay, and petroleum refining.

The topography of the region is that of an inter-mountain valley with the mountains rising 6,000 feet above the valley floor to the east and 3,500 feet to the west. These features combined with the meteorological characteristics of the area favor the accumulation of atmospheric pollutants, especially during the fall and winter months. Atmospheric stagnation periods of several days to several weeks duration may occur as often as 10 to 20 times per year.

There has been a marked growth of population and manufacturing in the Valley which has been accompanied by increases in certain domestic and industrial pollution emissions. In the opinion of various informed persons in the valley, the introduction of natural gas to the area, the accompanying decrease in the use of coal for space heating, and the installation of control devices by certain industries, have reduced atmospheric concentrations of particulate matter, fluorides, and sulfur dioxide.

No records were made available to verify verbally reported reductions in pollution levels, except the Public Health Service National Air Sampling Network data. These show that the average atmospheric particulate matter concentration at the Salt Lake City station has been decreasing

since 1954 and that for 1957-1958 it dropped to 115, a value below the national average of 131 micrograms per cubic meter. A wealth of climatological data pertinent to air pollution considerations is available.

Evaluation of factors affecting air pollution indicates that conditions will probably worsen if control activities do not keep pace. Although the trend toward increased use of natural gas will result in minimizing visible smoke and fly ash emissions, there will be a concurrent increase in certain other emissions. Increased urbanization and industrial growth coupled with the topography and meteorology of the area tend to favor development of a more severe air pollution problem.

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